

# Hot Stuff on Mussel Beach

Center for Sponsored Coastal Ocean Research  
NOAA's National Ocean Service

It may be a good idea to warm up your muscles before you exercise, but for animals such as mussels, warming up may prove to be too much of a good thing. Species living in the intertidal zone, between the high and low tide marks on the shores of the world's oceans, can be especially sensitive to climate variability. Animals and plants that live in this habitat are covered with seawater at high tide, and exposed to the air at low tide. As a result, their body temperatures can change greatly over the course of a single day. A Center for Sponsored Coastal Ocean Research (CSCOR)-supported project is determining how increasing temperatures may affect animals that live in the intertidal zone. Understanding the influence of long-term temperature changes on these species will allow us to predict changes in their distributions, and provide information for the management of coastal environments in a changing climate.

"As humans, we tend to have a very biased view of the world. We forget that changes in air temperature, which tend to have only very small direct effects on us, can have huge effects on other species," says project co-investigator Brian Helmuth, associate professor of biological sciences at the University of South Carolina (USC). "This is especially true for species that have temperatures driven primarily by the sun, wind and air temperature, much as the way your car heats up on a sunny day." In many cases these animals and plants have temperatures that are very different from the surrounding air, and two species living under the same environmental conditions can have very different body temperatures due to their shape, color, size and behaviors.

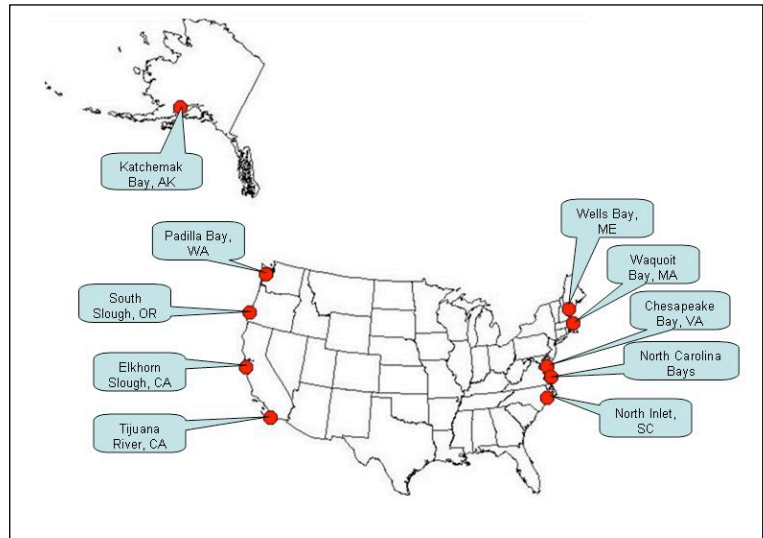
The USC science team has developed special miniature temperature probes, nicknamed "robomussels," that record temperatures being experienced by a mussel bed every 10 minutes for months at a time. Positioned at sites around the world, these instruments have shown that patterns in stress are often quite unexpected. Northern sites may be



*Size of the temperature sensor (Photo credit: David Wetthey, Univ. S. Carolina), and a "robomussel" (with yellow disk) in a mussel bed. (Photo credit: Brian Helmuth)*

hotter than southern sites due to the complex interactions between terrestrial weather, onshore water temperature, and the timing of low tides. For example, a northern site that is in the sun and out of the wind for most of the day could be warmer than a southern site that is shaded and exposed to the wind.

Study areas for this project include [National Estuarine Research Reserves](#) (NERRs) sites on the east and west coasts of the U.S. Some of these are rocky coasts, while some have sandy shores. The NERRs system is a partnership between NOAA and coastal states which provides a network of protected areas for long-term research, education and stewardship. The NERRs sites provided ideal locations for this project, because of their wide geographic range and the long term monitoring of temperatures and species present at the sites.



*National Estuarine Research Reserves included in the project. (Photo credit: Beth Turner, NCCOS)*

Species targeted for study include mussels, barnacles on rocky shores, and worms, burrowing shrimp, and sea urchins on sandy and muddy beaches. Mussels and barnacles are considered “foundation species” in rocky intertidal areas. They can control the distribution and abundance of other species in the habitat, because they are able to overgrow their competitors for primary space on the rocks. Burrowing urchins and other “ecological engineers” such as worms and shrimp alter the sediment by digging and burrowing just as gophers and beavers alter the terrestrial landscape. Because these species have a big influence on the structure of the ecosystem, understanding how they react to temperature changes can help predict what will happen to the larger system.

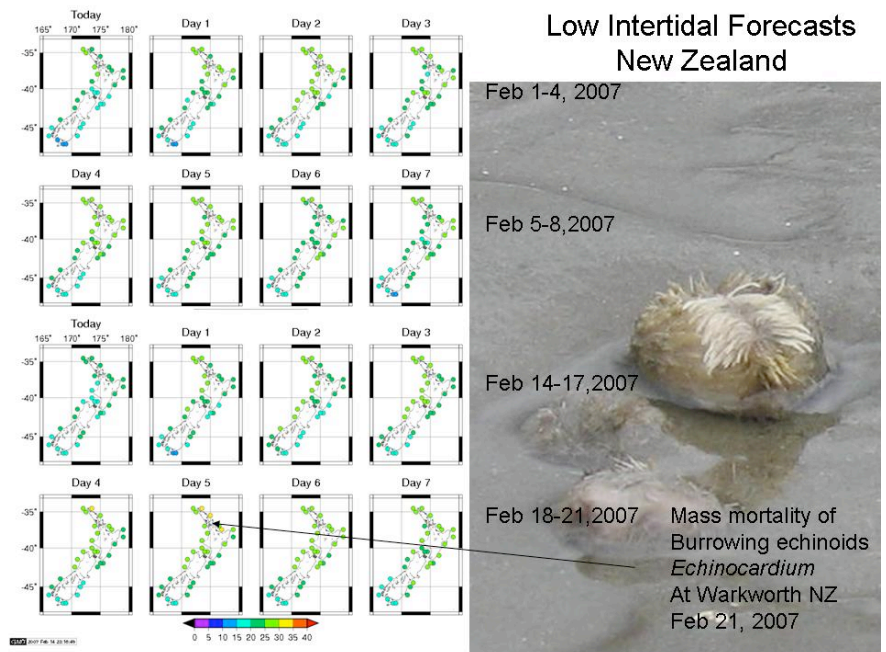
The temperatures collected by the “robomussels” are compared against the results of a computer model that uses NOAA and NASA weather data, as well as information on the animals themselves, to predict patterns of animal temperature. Results have shown that the predictions of animal internal temperatures agree very well with the model predictions. More importantly, the model results help to explain observations over the last 100 years that have shown shifts in where species live.

“The effect of temperature on geographic distribution of species holds true both on rocky shores and on sandy shores, which adds to our confidence in the results” says Sarah Woodin, another of the project’s co-investigators and professor of biological sciences at USC.

"Unfortunately, from what we can tell so far, California mussels are likely already pretty close to the edge, at least at some places along the West Coast. Our study suggests that climate change may start to kill marine animals in certain areas", Helmuth says.

In this context, the project director, David Wethey, a professor of biological sciences at USC, forecasts temperatures for intertidal zones around the world. In 2007, his model predicted that temperatures at a New Zealand site would exceed the tolerance of local sea urchins. When the site was visited, mass numbers of sea urchins were found dead. By being able to relate the die-off to temperature changes, the forecast was also able to eliminate other causes such as pollutants or disease.

The ability to predict patterns in the past gives the research team confidence that they may be able to forecast changes in species ranges in the future. By combining predictions of temperature with information on the temperature tolerances of different species, one goal is to provide resource managers and other scientists with "maps" of the probability of temperature stress at sites around the globe. This will help managers to plan for changes in coastal ecosystems, and help them to interpret species changes that may occur.



Temperature forecasts on the left and dead urchins on the right. (Photo credit: David Wethey, Univ. S. Carolina)

This project is part CSCOR's [Coastal Ecosystem Effects of Climate Change](#) (CEECC) program. This program focuses on the development of a predictive understanding of coastal ecosystem responses to climate in order to inform and facilitate management of the impact of climate change.